Universal Interconnection Technology (UIT)
Workshop Proceedings

Executive Summary

These proceedings provide the presentations and summaries of the discussions from the Universal Interconnection Technology Workshop, held on July 25-26, 2002 in Chicago, Illinois. This workshop, sponsored by the U.S. Department of Energy, Office of Distributed Energy and Electric Reliability, Distribution and Interconnection R&D, was organized to:

- Examine the need for a modular universal interconnection technology.
- Identify UIT functional and technical requirements.
- Assess the feasibility of and potential roadblocks to the UIT.
- Create an action plan for UIT development.

The UIT is envisioned as an open architecture for a standardized, highly integrated, modular interconnection technology that will come as close as possible to "plug-and -play" for all distributed energy resource (DER) platforms and a wide variety of applications. This technology would reduce costs by creating a large market for a core technology. Through firmware or software customization it would provide an expansion capability with the flexibility to adapt to a variety of needs and applications. The idea of the UIT is an outgrowth of industry feedback from a planning session at the first Distributed Power Program annual review two and a half years ago; subsequent projects with the Gas Technology Institute, Encorp and General Electric that the program has funded through the National Renewable Energy Laboratory (NREL); and the DOE/NREL DER System Interconnection Technologies Workshop held on July 24, 2001.

Industry representatives presented White Papers on UIT functions and features, present interconnection technology, approaches to modularization and expandability, and technical issues in UIT development. Individual company strategies were considered, including how well they may fit with UIT technology development. These presentations framed UIT issues that were the subject of considerable group discussion among the workshop participants.

Major Findings

During the Workshop, several major findings and points of consensus were reached.

UIT Definition

- Interconnecting DER with the Electric Power System (EPS) is traditionally a complicated process that can be improved, simplified, and made both more efficient and less costly by facilitating the combination of functions of previously discrete components into a more standardized, integrated, and modular approach, or modular Universal Interconnection Technology (UIT). Reaching consensus on the nature and definition of a UIT and its basic functions is an important step for the development of this technology. This consensus can be accomplished through dialogue between industry stakeholders, including DER manufacturers, interconnection component manufacturers, and UIT customers. The U.S. Department of Energy has an important role in this process, providing a platform for the exchange of information and facilitating discussion regarding the future of the UIT.

- A UIT would provide a series of functions critical for the successful integration of DER with the EPS. These functions would be made available through various individual modules,

either physical or logical, which in turn will be combinable to form an integrated interconnection system as required. As processes become more standardized, additional economies of scale will occur in addition to increased module flexibility and enhanced functionality.

UIT Functions and Features

- The UIT concept is analogous to personal computers – a set of core functions and capabilities is provided by the main board; flexibility, expandability, second sourcing, compatibility, and interoperability are achieved through modularity, a common bus structure and operating system, and firmware/software that can be adapted to different configurations and applications. Defining the core functions/capabilities and the common bus or system backbone structure is key.

- The core components of a UIT should provide for the minimum requirements of an interconnection system common to both inverter and non-inverter applications.

- Defining the specific functions and features to design into a UIT is of paramount importance to its ultimate development.

- General agreement was reached on the core functions that should be included in a minimum UIT configuration. These were:

  - Anti-islanding
  - Autonomous operation
  - Ability to withstand the environment in which it operates
  - Power on/ off
  - Power reset
  - Synchronization and verification
  - Import/export control
  - Voltage, frequency, phase angle, and current as key inputs to the UIT
  - VAR/power factor control
  - DER failure indicator
  - Testability (of the UIT)
  - Meeting all 1547 requirements
  - Self diagnostics
  - Non-volatile set points

- In addition to the core functions, the UIT architecture should accommodate expanded capabilities and various configurations: i.e., inverter as well as non-inverter systems; DER located near the point of common coupling (PCC) or DER located at a distance from the PCC; single DER or hybrid systems; central control as well as localized intelligence; and interface with utility dispatch, aggregators or enterprise energy management systems.

- Considering there are engineering trade-offs when building any device, the workshop participants placed particular emphasis on affordability, reliability, modularity, maintainability, and testability as key features that should be included in an optimal UIT design.

- Two paths (or subsystems) were identified: 1) Power subsystem or path; and 2) logic and control path – with communications and data links between the two paths.

- A key component of a UIT is having a controller that has a standardized interface with the other components of the interconnection system, so that different manufacturers' controllers would be interchangeable, providing flexibility, expandability and second sourcing.

Feasibility and Potential Roadblocks

- Object models will be important for self-configuration and plug-and-play operation.

- Utility acceptance may depend on familiarity – providing a single way to interface and test from a utility point of view, i.e., standardization.

- Industry participants expressed a strong opinion that the application firmware/software should not be standardized, since this is critical to product differentiation and protecting the companies' proprietary property.

Conclusions and Next Steps

Participants supported the concept of a UIT and felt that its adoption would result in lower costs for interconnection and increased use of DER. The group identified a series of "next steps" for moving forward with the development of a UIT. These steps include:

- Develop working definitions for each of the UIT functions identified at the workshop.

- Develop functional block diagrams of interconnection systems for a variety of DER configurations to aid in synthesizing the UIT.

- Convene a series of one-day workshops to develop a functional block diagram for the UIT and identification of the core technology.
  - One workshop to develop a functional diagram for non-inverter applications.
  - A second workshop to develop a functional diagram for inverter-based applications.
  - A third workshop to synthesize the inverter and non-inverter diagrams into a UIT and develop a UIT requirements document.

- Develop a roadmap for further defining the individual pieces within each UIT block diagram and the interfaces between them.

- Develop a list-serve for continuing discussion and work on developing the UIT.